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ABSTRACT

A study examined the effects of formal and informal learning environments on the storage and recall of lexical items in the first and second languages, paying specific attention to laterality and accuracy rates for tasks of varying difficulty. The study used the dichotic listening task and subjects whose first language was English and whose second language was Spanish. Results indicate high accuracy and low laterality for English, a predictable result considering the subjects' familiarity with the language. In Spanish, marked differences were found in the subjects' accuracy of recall and degree of laterality, relating to the second language learning environment. In general, the results supported the hypothesis that as the difficulty of the language task increased, the recall accuracy would drop and the laterality effects would increase, that a commensurate difference between accuracy and laterality for language would appear, and that the differences would be significant between learning environment groups. However, the hypotheses were not substantiated to the degree anticipated. (MSE)

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ED298757

Paper presented at the Eighth Annual USF Linguistics Club Conference on Second Language Acquisition and Second Language Teaching, 5-6 February 1988, Tampa, Florida

THE EFFECTS OF TASK DIFFICULTY AND LEARNING ENVIRONMENT ON THE PROCESSING OF VERBAL INPUT AS MEASURED BY THE DICHOTIC LISTENING PARADIGM

INTRODUCTION AND RATIONALE

With the advances in neurology and brain research over the past few decades, a small but growing number of linguists have been trying to relate this research to what we know about language in general in order to determine how language might be represented in the brain. Obler (1983) succintly states the goal of these neurolinguists as determining "...how language is organized in the brain and how it is processed by the brain" (p.159). Unfortunately, this research is hampered by three simple yet persistent problems: 1) inadequate knowledge about the brain itself; 2) inadequate knowledge about language itself; and, 3) inadequate methods for comprehensively studying either 1) or 2). Such problems might cause pessimism among researchers such as that exhibited by Scovel (1982), leading to questions such as: Why bother to pursue a neurolinguistic perspective (at least for now)? and What value does neurolinguistic research have for me, a language teacher or "applied" linguist? Cook (1981) argues for research, saying that it should take place in order to directly influence the development of classroom methods. Research and teaching cannot be mutually exclusive, especially when both deal with the brain.

If any two fields should be closely allied, they should be brain research and language teaching. Part of the reason for the seeming failure of "traditional" methods of language teaching is that their theoretical base does not include research findings from studies that examine how the brain actually works, only research that examines what seems to be occurring in the learner, ie. behavioral research. In all fairness to the behavioral school, there simply was not much data on brain processes twenty or thirty years ago. But even with developments of the past fifteen years, neurobiological research and language pedagogy are as far apart as ever, and Walsh and Diller's (1978) call for a greater effort to relate the two still goes essentially unheeded after ten years.

What should command a greater share of research attention in SLA is how language is actually stored in the brain, and how it is later accessed for output. Also, not all input encountered in a given situation is learned or acquired, or becomes "intake" (Krashen 1981). Intake occurs only as the learner is "actively involved with the content" (Tollefson et al. 1983). In addition,

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the way in which the brain accesses the learned/acquired information can also affect the output. These and other storage and access processes are not adequately dealt with in existing models of SLA, and will never be successfully explained by relying solely on behavioral research (Lamendella & Scovel 1979).

The study presented here is an attempt to provide some data from the linguistic-oriented brain processes using a well known tool, the dichotic listening task. The study was inspired by and partially replicates a recent study by Mohr and Costa (1985) concerning task difficulty. Difficulty is a factor heretofor unexamined in dichotic tasks, and provides a novel use of an old paradigm. In addition, this study also introduces the idea of learning environment effects on the storage and retrieval of the lexical items which make up the listening task. It is expected that there will be differences between the two groups involved in the study for their second language, Spanish. Hopefully, the results will raise questions about the effectiveness of classroom language programs, especially those that have the purpose of producing effective second language speakers.

REVIEW OF LITERATURE

Data on language processing in the brain have come from four main populations: 1) normal monolinguals; 2) abnormal monolinguals; 3) normal multilinguals; and, 4) abnormal multilinguals. Much of the early interest in studying the brain came from individuals whose language capabilities had been altered by some sort of lesion or infirmity. Today, much of neurolinguistic research continues to concentrate on abnormal populations, in part because these groups allow access to areas of brain study, such as electrical cortical stimulation, that would not be ethical practice among normal populations. But the fact remains that most multilinguals possess normal brains, and most language classrooms are populated by normal learners. Therefore, it is of practical interest to pursue methods of studying the brain through common, everyday, language learners.

A mainstay of the research into both normal and abnormal populations have been studies investigating the idea that language lateralizes to one or the other hemisphere of the brain, and that this hemisphere then becomes "dominant" for language in an individual. Lenneberg's seminal work in the sixties studied such questions as: When does this lateralization occur? And to what hemisphere? Current thought generally accepts the idea that in most people, perhaps well over 80% of the population according to Coren and Porac (1981), the left hemisphere is somehow prepared to "subserve" language functions from birth, and does so, barring some type of neurological alteration (disease, damage, etc.) (Kinsbourne and Hitchcock 1977). Rhawn Joseph (1982) presents biological support for lateralization to the left in his monograph on developmental psychology, presenting evidence

for the more rapid neuronal development of the left over the right hemisphere. This gives the left an advantage in gaining control first over the motor systems, necessary for language production, as well as the callosal connections between the hemispheres, hence "dominating" the right. It bears repeating again here that neither hemisphere is completely responsible for all aspects of language, and, in fact, language skills are not only the domain of the higher neo-cortical hemispheres, but other regions of the brain, such as the limbic areas, as well (Lamendella 1977).

Having mentioned some generalities true of all who have language, let us consider for a moment multi-linguals and their acquisition and organization of language, since that is what this study is concerned with. Throughout this paper the terms "laterality", "lateralization", and "dominance" will be used in much the same way as Obler (1983: 173) uses them; the first term being neutral, the second denoting an ongoing, dynamic process ending around puberty, and the last a more static term emphasizing the importance of one or the other hemisphere for performing a given linguistic task.

Of the studies more directly examing cerebral processes, up until now, some general trends have been demonstrated. Fortunately, several researchers have perused and analyzed many hundreds of the available clinical studies so that one is not required to repeat such a task to see the trends (see Galloway 1982 and 1983; Moscovitch 1977). These clinical reviews also support the notion that the left hemisphere is the processing center for language, whether that be syntax or indivudual phonemes (Molfese, Molfese and Parsons 1983). The right hemisphere has not been left alone, however, and in recent years has garnered its share of attention. Among the skills claimed for the right are comprehension of syntactic wholes, word recognition, and intonation patterns (Zaidel 1977; Hecaen 1977; Galloway 1981; Gazzaniga 1985).

As already mentioned, up until a few years ago studies purporting to look at cerebral processes were hampered by ethical and technological limitations. In addition to these practical limitations, ignorance of variables affecting studies of language processes in the brain also make for many inconsistencies and varying conclusions in early studies. Such factors as previous language experience, sex, or handedness were sometimes ignored. Today, these and other factors are recognized as important factors affecting the outcome of neurolinguistic research, even if the reasons why they do so are not yet completely understood. Three key papers have appeared in recent years which comprehensively deal with these factors, and the reader is invited to consult them for a comprehensive review. They are Obler et al. (1982) and Galloway (1982 and 1983). Here, only

those factors directly relating to the study at hand will be presented.

A. Subject Variables: Handedness is probably the most well-known subject variable known to effect the outcome of laterality studies. As mentioned before, earlier studies did not always control for handedness. More recent attempts to actually isolate and examine the relationship of handedness to laterality have had inconclusive results (Oller et al. 1982; Segalowitz and Bryden 1983), but researchers agree that handedness can be a confounding factor if not controlled for (Galloway 1983). Most recent studies use only right-handed subjects.

Sex is another variable receiving more attention recently. Claims have been made for differences in "strength" of laterality for different tasks between males and females. In the general population, it appears that males have a more pronounced lateralization than females (Wittig and Petterson 1979. Tests of cognitive style also point up the same general trend (Bryden 1977). In other words, for a given task, females seem to rely more on both hemispheres than on just one or the other, as do males. Dichotic listening studies have not shown up the same differences, but the number of studies concerned with sex differences have been few. It appears that dichotic studies which have taken care to control for sex have not encountered difficulty. Galloway and Scarcella's (1982) study involved only males, and Mohr and Costa's (1985) study had equal numbers of males and females. In Galloway's review of the bilingual literature (1983), the general trend for greater female symmetry did appear, except for two studies where sex seemed to play a role in early bilingualism, but not later on.

The age of subjects actually has two important subdivisions: 1) age at time of testing, and 2) age of acquistion of the L2. Both of these factors have been ignored to some extent and, worse, the distinction between the two has not always been recognized. With regard to 2), Vaid (1981, 1987) has proposed that the earlier an L2 is acquired in relation to the L1, the more similar the acquisition process for both languages will be, e.g., the more semantics will play a role, and "deeper" processing will take place, whereas in later learners of an L2 the focus will be more on surface features and analysis of forms. This hypothesis has important implications for language teachers (Celce-Murcia 1985). The analytic attitude which later learners seem to have towards language learning is also a result of the academic environment they have been exposed to (Lozanov 1977). Vaid (1983) conludes her paper hypothesizing greater initial left hemisphere involvement in L2 learning 1) the older the learner, and 2) the more formal the instruction. On the other hand, the right hemisphere would be expected to play a greater role 1) the younger the learner, and 2) the more informal the exposure to the new language.

B. Proficiency: This important factor has sometimes been overlooked perhaps in part because the very notion of language proficiency is ill-defined and not easily measured. It is sometimes confused with age of L2 acquisition, but should not be, even though the relationship between the two is still not well delineated. The role of this variable in the current study will be examined more closely in the discussion section.

C. Teaching Method and Learner Preference: This is the core variable the present study addresses. The premier study concerning learner preference is Hartnett (1975). In that study she had two Spanish classes in which students enrolled according to their "cognitive" preference: a grammar-deductive method or an inductive method. She found a significant match between student preference and teaching method. These results were much cited as showing that learner preference and attitude had as much to do with language learning "success" as did method. Since then, however, there apparently has not been any interest in attempting to replicate her findings, and she herself was unable to do so in a later study (personal communication).

D. Environment: Another key variable rarely studied is learning environment. This variable is directly related with teaching method. Although educational research has long dealt with learning environments in general, more second-language specific work needs to be carried out in order to determine, for example, the effects of early natural exposure as opposed to later exposure, or the effects of formal exposure preceding or following natural exposure. Intuitively it would seem that formal exposure would lead to a different cerebral organization of language than would informal (or natural) exposure. The two groups of interest in this study are differentiated precisely by this variable.

Careful control of these and other variables, when applicable, serve to 1) improve the overall picture of the language acquisition process; 2) better research methodology for studying language lateralization in monolinguals (Obler et al. 1982); and, 3) "help clarify the educational implications of this [brain testing] line of neuropsychological inquiry" (Galloway 1982: 26. This last reason is perhaps the most important of the three.

One final area of L2 research of relevance for the current study is that of hypotheses dealing with the acquisition/learning process. The ideas of Vaid mentioned above regarding age of acquisition have also been examined by Obler (1981), who conluded that the right hemisphere is more active in initial language acquisition than later on, even when such acquisition occurs after puberty. Obler's hypothesis came to be known as the "Stage Hypothesis". In essence it says that the right hemisphere will be

more involved in L2 acquisition than in L1 acquisition, especially in the early stages of exposure to the L2. A review of the available literature in light of this hypothesis, though, showed that many bilinguals seemed to have a greater involvement of the left hemisphere in L2 acquisition. In order to account for such discrepencies, a "modified" Stage Hypothesis was proposed by Galloway and Krashen (1980). Basically, this version allows for a greater involvement of the left hemisphere in cases of formal, conscious language learning, as opposed to those learners who acquire the language in a more informal setting. An attempt by Galloway and Scarcella (1982) to provide empirical support for this new version was inconclusive.

Of interest here are the two possibilities to which the assumptions underlying such a hypothesis lead. These were succintly pointed out by Schneiderman (1983): "Either there are two different processes of acquisition, one of which occurs in a formal environment and engages different cerebral mechanisms from the other, or learning does become acquisition and the process somehow results in an enhances degree of left lateralization for second languages so mastered" (p.339).

The Stage Hypothesis has a bearing on the present study inasmuch as the two groups in this study are similar to the two types of learners with which the Hypothesis concerns itself. Included in the Hypothesis and this study are assumptions about proficiency which need to be accounted for. In her review of studies to find support for the Hypothesis, Galloway (1983) uses the term "proficiency" as relating to the "stage of acquisition"; that is, one is proficient if in later stages of acquisition, and non-proficient if in the early stages. No correlation is made with the amount of exposure considered to qualify one as "advanced" or "beginning". What is important, and what the reader should keep in mind in examining the data from the present study, is this definition of proficiency as the time of exposure to the L2. Again, the ramifications of such a definition will be dealt with in the discussion section.

Hypotheses

The question of interest for this study is: What is the effect of the learning environment on lexical organization as measured by the Dichotic Listening paradigm? A secondary question is also involved: What is the effect of the difficulty of the task on this organization? It was hypothesized that there would be significant differences between the two groups for Spanish, but not English, as measured by word recall accuracy scores as well as the laterality coefficient used.

METHOD

Subjects

Twenty-four volunteers from the Spanish Department at Brigham Young University participated in the dichotic listening task. Half came from the 202 level courses and half from the 302 level courses. This latter course is perhaps unique to BYU in that it is composed of returned missionaries who have spent up to twenty-two months in a spanish-speaking country (sixteen months for females). The 202 students are beginning their fourth semester of college Spanish, and were allowed up to two years of High School Spanish. Through many years of experience with these two types of students, the department has developed these two courses to "equalize" the respective students prior to their integration in the fifth semester of coursework. It was determined in consultation with members of the Spanish faculty, though not by some standardized measure, that these two groups of students were compatible both with respect to exposure to the language and listening comprehension, for the purposes of this study. Ages ranged from 19-25 years old.

Variables controlled for included handedness, sex, and language experience. As mentioned, the 202 students might have had as much as five school semesters of Spanish. This group was designated "formal". The returned missionaries had received about eight weeks of intensive Spanish memorization of church-related discussions, but no other formal training in Spanish. It would, of course, be preferable for the purposes of contrast not to allow these learners any formal instruction, but such a scenario was not possible. As it was, more than 200 potential subjects were surveyed, and only 24 actually participated. The returned missionaries were designated the "informal" group.

Potential subjects were also asked if they had any hearing impairments, and were not allowed to participate if the answer was positive.

The final 24 participants were divided equally into two groups of twelve, with six males and six females in each group.

Tape Preparation

The dichotic tapes used in this study were prepared by hand in the absence of a computer program for doing so. The method is that outlined by Carl Rubino (n.d.).

Words were concrete nouns chosen at random from Word Frequencies of Spoken American English (Dahl 1979, Appendix A). A spoken frequency list was chosen over a written one since the subjects would be hearing and not reading the words. For replicability with the Mohr and Costa study as well as to keep meaning roughly the same, the English words chosen were then translated by a native-speaking Spanish bilingual into equivalent nouns.

Natural and not synthesized speech was used, with a native speaker of both English and Spanish recording the words which were then edited into the dichotic tapes. Recording was done using a Revox BK77 reel to reel and Maxell 35-90 high bias tape. Work tapes were made using TDK SA-90 cassettes. Recording level was kept between 70-90db. A split-screen oscilloscope was employed to keep word onset of the dichotic pairs at between 5-10 milliseconds. The task difficulty aspect of this study required that word pairs be grouped together: two pairs (four words total) for the two-word pair (2WP) condition, three pairs (six words) for the three-word pair (3WP) condition, and four pairs (eight words) for the four-word pair (4WP) conddition. Word pairs appeared at about one pair per second, with a ten second interstimulus response time in between word pair groups. At each difficulty level, there were seven groupings of the word pairs, after which the pairs were rearranged in seven different groupings, giving a total of fourteen word pair groups (2WP, 3WP, 4WP) at each level of difficulty. This repetition was necessary to allow each word to be heard once in each ear.

Instruments

A self-report handedness/language experience survey was given to potential subjects (Appendix B). The auto-reported items used in this survey have been shown to correlate highly with actual behavior; in other words, the survey was developed using subjects who first were asked the questions in writing, then actually performed the tasks. For the survey used here, Porac & Coren (1981) reported better than 90% agreement between self-report and performance on the items even after one year. For consistency in usage, the survey was "scored" in the following manner: if the subject said the right hand was used a +1 was given, if the left hand a -1, and a 0 for unsure. The result was a number between +1 and -1. Multiplying by 100 gave a score which could be read on a 0-100 scale. For this study, only "strong" right handers, ie. those which had a score of 61-100, were accepted.

Procedures

All potential subjects were given the handedness survey approximately one week before testing. The class previous to the test, each participant was given a short description of the dichotic paradigm and written instructions which were repeated vocally at the time of testing (Appendix C). No mention was made of the selection process, the design of the experiement, or that two different groups were involved.

At test time, each subject was given a headset for listening, and a tape recorder for responding. The tape recorder was left running for the duration of the experiment to avoid distracting the subject. Subjects were told that they would hear

words in English and Spanish through the headphones. After each group of words there would be a short time for them to repeat vocally everything they remembered.

To control for intersubject differences half of the subjects began the task with the left and right channels of the headphones reversed, and then after seven word pair groupings, all subjects reversed the headphones. This resulted in half the subjects in each group hearing the first seven word pairs in each difficulty level with the A-track in the right ear, and half with the A-track in the left ear, and then vice-versa.

Analysis

From the tapes with subjects' vocal responses, a measure of accuracy was computed for each student in each of the three word pair conditions. This measure consisted of the number of words correctly reported from the right (Rc) plus the number of words correctly reported from the left (Lc), divided by the total number correct.

Next, a laterality index was computed for each subject using the common formula Rc-Lc divided by the right errors (Re) minus the left errors (Le). This was also computed for each word pair consition. This is the same formula used by Mohr and Costa. Laterality formulas have been the cause for debate in recent years. A study of the five most commonly used laterality coefficients was conducted to examine inter-reliability, and it was found that especially for the dichotic listening task, a high inter-correlation was obtained for all, and each one also significantly correlated with a measure of overall accuracy (Hellige, Zatkin & Wong 1981).

Having obtained a measure of accuracy and a laterality coefficient, a 4-way repeated measures ANOVA was run. The computer program used was the "Rummage" program from the Statistics Department at BYU, and run on the VAX 8600.

RESULTS AND DISCUSSION

Table 1 presents the group means for accuracy and laterality ratio for the group, language, and difficulty level. The trends predicted by the hypotheses show up here. It can be seen that both groups show a high accuracy and low laterality ratio for English, demonstrative of a high degree of familiarity with the language, which is to be expected. As the task becomes more difficult, the ratio increases, though not too dramatically. In Spanish, however, we see marked differences between the two groups, first in the lower overall accuracy of recall, then in obvious differences in laterality scores between groups. These data are better represented and easier to see in the following graphs and accompanying discussion of the results.

Table 1

Means for Accuracy and Laterality by Language and Group

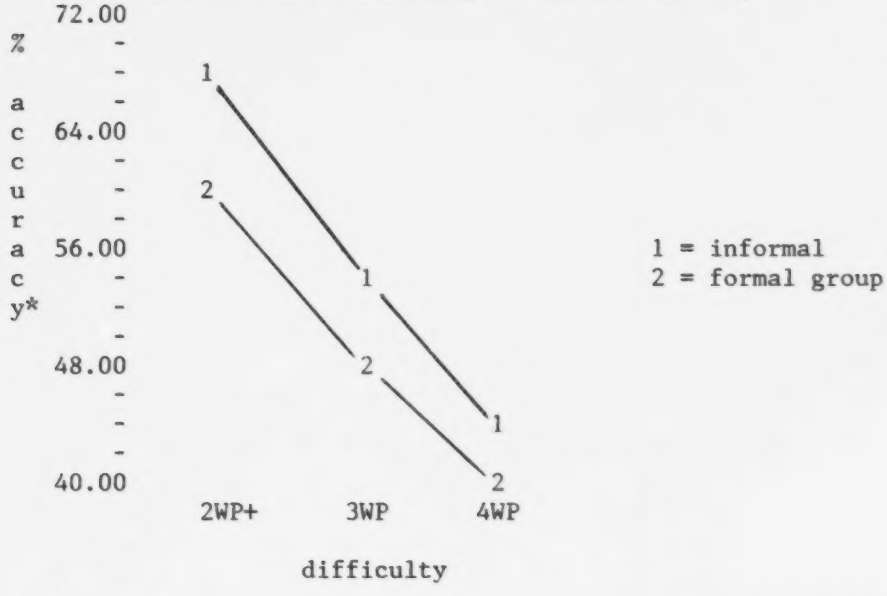
	2WP %/LC	3WP %/LC	4WP %/LC
(formal)			
English	72.01/.019	59.92/.04	46.86/.102
Spanish	48.80/.145	37.16/.186	31.14/.207
(informal)			
English	69.34/-.001	57.64/.05	45.16/.093
Spanish	63.54/.028	51.59/.092	43.68/.056

Accuracy

Accuracy provided the majority of significant interactions in this study. A highly significant effect of difficulty on accuracy was obtained ($f=127.5$; $p<.0001$). This result was expected, since it shows that as the task became more difficult, the ability to accurately recall the word worsened (see Figure 1).

Figure 1

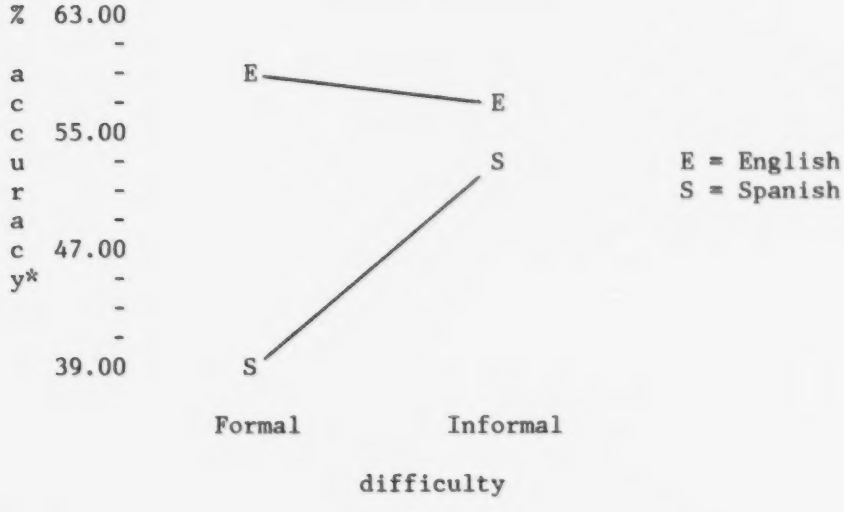
Effect of Task Difficulty on Recall Accuracy



* = total # words reported correctly / total possible words
\+ = word pairs

Figure 2

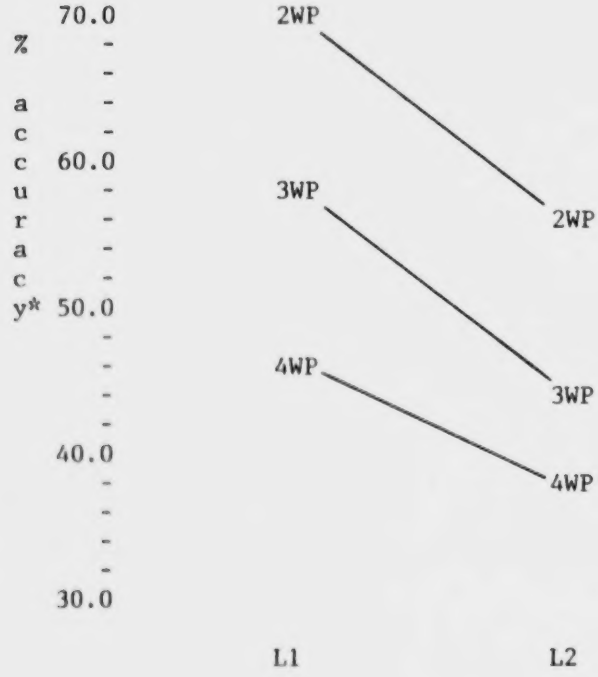
Effects of Language and Learning Environment on Recall Accuracy



There was also a highly significant Group x Language x Accuracy interaction ($f=33.52$; $p<.0001$), which is harder to interpret, but follows the expectations of the study (figure 2). Both groups are composed of native English speakers, so there should not be any appreciable difference between groups, but there should be differences between groups for Spanish if the groups are not equal for some reason. The graph shows that both groups were quite similar in recall accuracy for the English words but very different in their Spanish word recall accuracy. The other significant interaction supporting between group differences dealt with Language x Difficulty on Accuracy ($f=3.72$; $p<.03$, Figure 3). From English to Spanish we see a marked drop in accuracy for both the 2WP and 3WP conditions, as well as the 4WP condition, but the drop to the last level was not as great. The fact here is that the groups performed differently in English and Spanish as the difficulty increased. This pattern is similar to that seen in the Mohr and Costa study, and was expected for the present study also, although in the former study the effect was significantly greater.

Figure 3

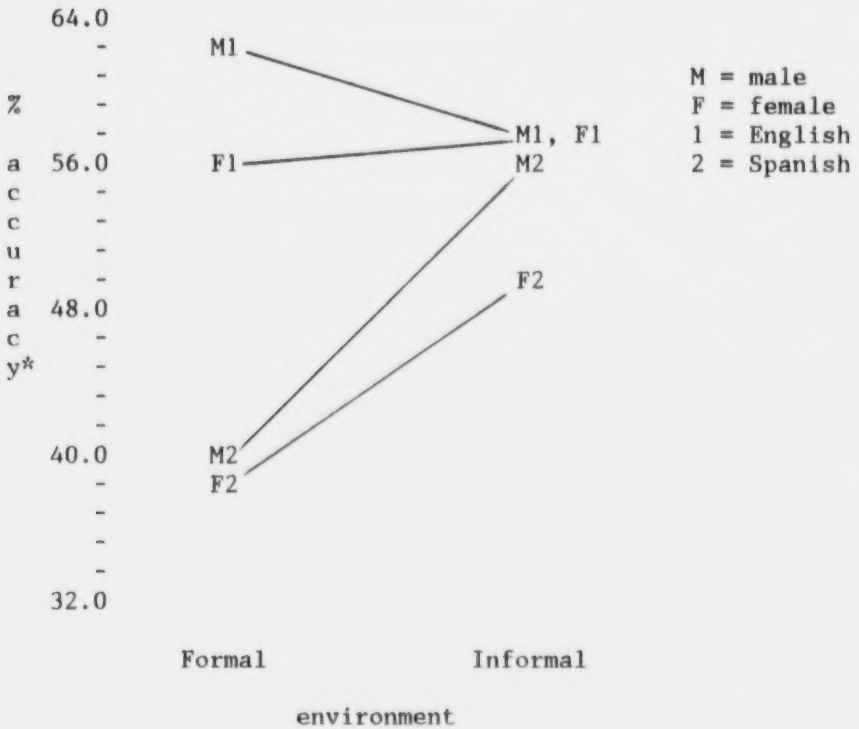
Effects of Language and Task Difficulty on Recall Accuracy



The last significant interaction regarding accuracy appeared in Group x Sex x Language on Accuracy (Figure 4). It can be seen more readily on the graph that the males maintained higher accuracy even as the task became more difficult, both between groups and for all difficulty levels. The lower overall proficiency for females may reflect the fact that they were exposed to the language for six months less than the males.

Figure 4

Effects of Learning Environment, Language, and Sex on Recall Accuracy



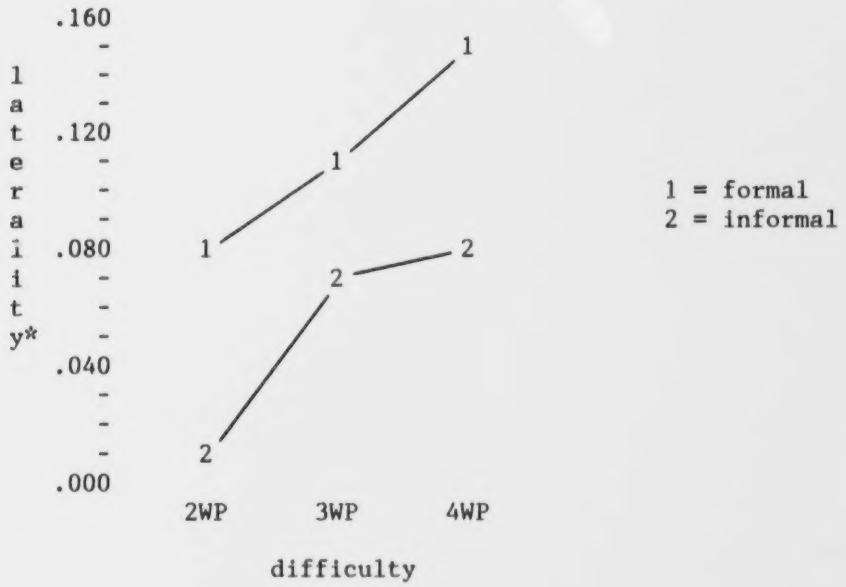
laterality

Figure 5 shows a significant effect of difficulty on laterality ($f=4.25$; $p<.02$). This is taken to show that as the task became more difficult, the dependence upon one or the other hemisphere increased. Since the LC (Laterality Coefficient) was positive, processing responsibility was on

the LH. This is the same type of relationship seen in the effect of difficulty on accuracy (Figure 1).

Figure 5

Effects of Task Difficulty and Learning Environment on Laterality



* = words reported RE - words reported LE / total words reported.

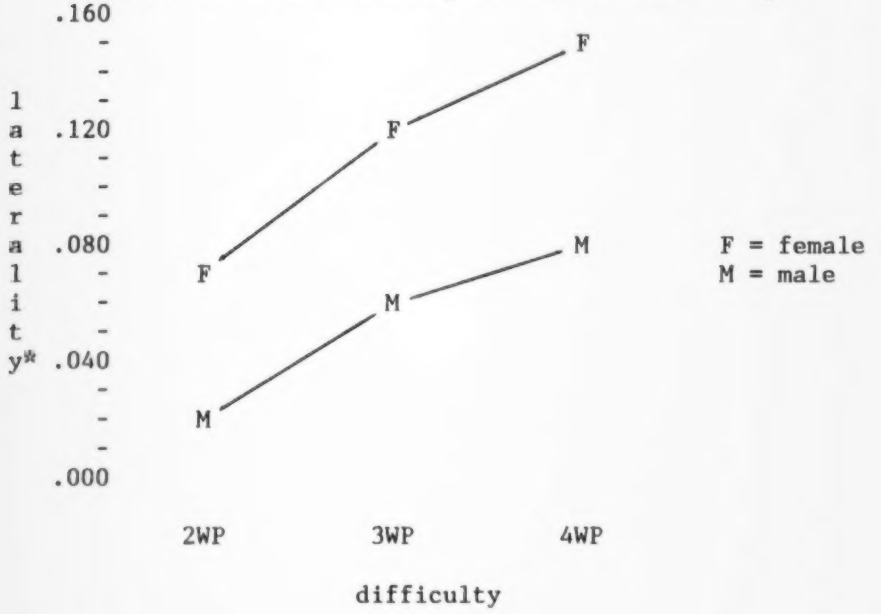
Unfortunately, the claims this study wanted to make for laterality differences between groups were not substantiated by significant statistics. It was hypothesized that there would be significant differences in the two groups' laterality scores. This prediction was not supported. Nevertheless, it is still enlightening to review several graphs representing the interactions of the different variables of interest for this study with the LC. These show the expected trends predicted for the study, including one which approached significance.

In Figure 6 we see the interaction of sex and difficulty with the LC. Interestingly, the females in this study showed a higher LC than did the males, a trend not to be expected from past studies and current beliefs expressing greater asymmetries for females.

Diagrams 7 and 8 encapsulate this study. It was expected that there would be significant differences between the formal and informal groups' Spanish word processing, measured by the laterality ratio, as the dichotic task increased in difficulty. In Figure 7, we can see in the native language a climb in laterality as the difficulty increases, but notice that both groups are essentially equal. In Spanish, however, there are wide discrepancies. It is interesting that the formal group almost has a straight line for both languages. The informal group, though, demonstrates very inconsistent LCs for the different difficulty levels. The trend for differences between the two groups is seen, but was not significant statistically.

Figure 6

Effects of Task Difficulty and Sex on Laterality



* = words reported RE - words reported LE / total words reported.

Figure 7

Effects of Learning Environment and Task Difficulty on Laterality for English

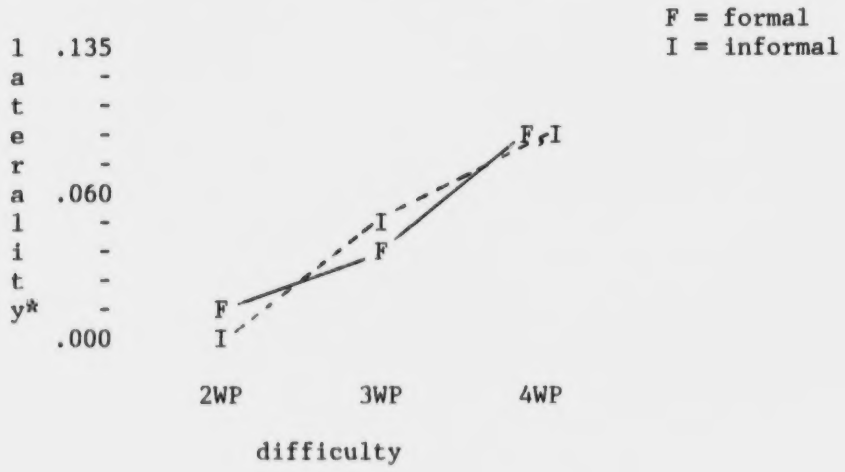
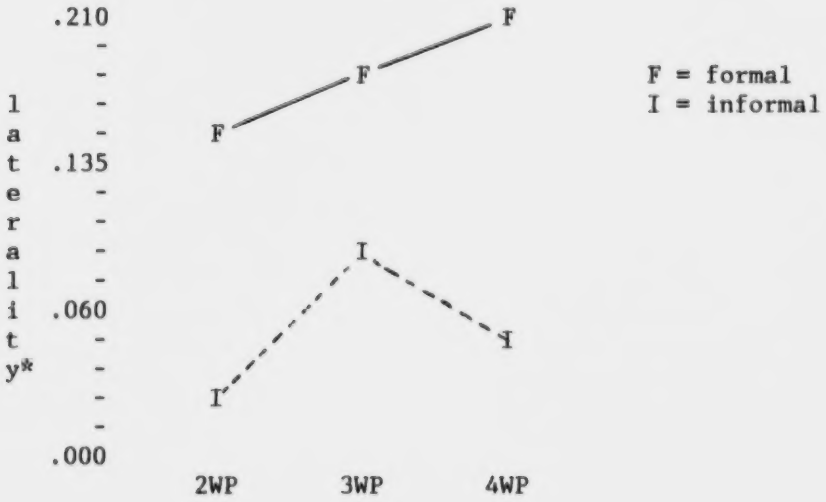


Figure 8

Effects of Learning Environment and Task Difficulty on Laterality for Spanish



* = words reported RE - # words reported LE / total # words reported

DISCUSSION

In spite of the fact all statistical analysis failed to support the important hypotheses presented in this study, the results are by no means insignificant. Generally speaking, all of the data support the original hypotheses, which were that as the difficulty of the language task increased, the recall accuracy would drop, and the laterality effects would increase; that there would be a commensurate difference between accuracy and laterality for language, and that the aforementioned differences would be significant between groups.

Most of the differences within groups were significant; most non-significant results related to between-group differences. Nevertheless, a look at the figures shows that in every case the expected trends appear. The corresponding drop in accuracy and rise in the LC for task difficulty is taken to show the overloading of the word processing systems. Where the LC is highest, the left hemisphere is assumed to be doing most of the work. It stands to reason that if a linguistic form has been learned by drill, analysis, repitition, etc., chances are that such a form is accessed more readily by the left hemisphere. A mroe native-like, bi-hemispheric representation will show a lower LC. Depending upon the demands of task and word type, single words can be processed by both the right and left hemispheres, so it is not surprising to see low LCs in English, especially for the lowest difficulty level. The expected trend for Spanish is demonstrated by the graphs. The informal group had the lowest LCs for all difficulty levels as well as less between-level differences.

Why were there any differences at all between the groups? The claim made here is that the learning environment has allowed the brain to process and to store the words heard on the tapes in a different fashion for the different learners. It goes without saying that there are no simple claims to be made here. First of all, one might argue that the groups are not matched. The "informal" group did have eight weeks of intensive, memorization-type instruction, but they were the closest thing to non-classroom learners available at the time. The equivalence of the subjects could serve to equalize results.

However, the most probable reason for non-significance in the present study is samle size. It bears repeating here that in Galloway's survey of bilingual studies, the single most important factor she demonstrated providing significant results was the number of participants in the study. Groups of more than forty almost always provided significant results, while smaller groups did not. The groups in this study had fewer than half that number.

The words chosen as stimuli can also affect the outcome of dichotic studies. The Mohr and Costa study used beginning learners in a six-week intensive course. The learners in this study already had at least a couple of years experience with the language. Perhaps the non-significant between-group results is also a factor of the subjects' equivalence for the words used (high frequency concrete nouns).

One unexpected trend which showed up in the data can be seen in figures 3, 5, 6, and 8. These show a large discrepancy between the 2WP and 3WP conditions, but not much of one between the 3WP and 4WP conditions. A couple of instances of this trend can also be seen in the Mohr and Costa study. Reasons for such a trend should be explored. They might be related to the stages children go through in primary language acquisition; that is, while for a second language learner two and three-word pair groupings might represent natural acquisition/grouping levels, four-word pair groupings might not, and therefore presents no greater processing difficulty than three-word pairs. Such a postulation must be seen in the light of the fact that all words here are nouns, but the idea that there might be some sort of processing grouping or perhaps saturation level for this type of task is intriguing.

On a seemingly related point, the response tapes provided provocative questions not expected beforehand. The ways students responded appeared to demonstrate processing/recall strategies employed in order to increase performance. A subset of students seemed to get into a "rhythm groove" once in a while. This strategy is best described as a methodical, rhythmic recalling of the words in the order heard, giving the impression of little effort expenditure. It allowed one male subject to repeat all eight words in the 4WP groupings three times in a row, and this in Spanish, a second language. Several other subjects performed similarly. Another subset of subjects employed a filler word while recalling so as not to lose the rhythm (eg. dog, cat. something, house, something, man). In both cases the rhythm/grouping of the words had some relation to accurately recalling as many as possible.

Another point needing emphasis here concerns the external validity of the study. Such results as obtained must be interpreted with caution. The task here is only word recall, and cannot represent the entire spectrum of language and language learning. The dichotic task here deals with processing of single words, and so direct application to teaching methods would be inappropriate.

This researcher will argue that the differences obtained between the groups are directly (in some fashion) related to differences in cerebral organization for Spanish between the groups, and that this organization was effected in part by the learning environment the subjects experienced. There is

compelling evidence for such a claim. That each of the two neocortical hemispheres are responsible for overseeing different tasks is accepted today by most researchers. That the left hemisphere takes on the analytic/logical processing responsibilities, for example, is not widely disputed. Through the selection process used, the subjects in this study can be considered to be left dominant for language. But in a given linguistic task, many features are involved in the processing of input. A native speaker of the language in question will bring to bear both analytical and holistic systems to the task at hand. As a task becomes more novel, foreign, and difficult, the left hemisphere plays a bigger and bigger role, in both the first language and the second. Therefore, results which demonstrate a major involvement of the left hemisphere in a task would point to an unfamiliar and/or difficult task.

For native speakers of a language, high frequency concrete nouns should not represent a great problem for either recognition or recall. In a second language, difficulty in performing the above named tasks would be manifested in greater left hemisphere involvement. If we suppose that a classroom truly facilitates language acquisition, the result should be language processing approaching native-like processing (though perhaps moreso for children than for adults). If, after three or four years in the classroom, learners are still relying to a greater degree on the left hemisphere than an identical learner who has had natural exposure to the language for less time, then there is reason to reevaluate what is occuring in the classroom

No discussion of the results would be complete without a short digression on the role of proficiency. It could be argued that equality or inequality of the two groups involved in this study could simply be the result of the subjects' language proficiency. However, if the data is considered in light of the Stage Hypothesis then there is little reason to believe the data obtained would be affected by proficiency, as this term is defined in the literature dealing with the Huypothesis.

The Hypothesis, summarized earlier, postulates that while there will be no significant differences between the laterality scores for the two languages of proficient bilinguals, there will be significantly greater left hemisphere involvement in early L2 acquisition for L2 learners in a formal setting, but no significant left hemisphere involvement for L2 learners in an informal setting. Two dozen studies showed no significant differences for proficient bilinguals, as predicted. Several studies with non-proficient bilinguals showed no significant differences, either, for learners in the initial stages of acquistion. But non-proficient bilinguals in the early stages of formal acquistion did show high right ear effects, indicative of greater left hemisphere involvement. Interestingly enough, these trends hold true across a wide variety of languages as well as

ages. The important point here, though, is that the learners in these studies are in the initial stages of formal learning.

Relevance to this study, then, is two-fold. First, the subjects in this study, judging only from the amount of experience and class level, are probably not in the early stages of learning/acquiring Spanish. Second, there are two distinct groups of learners from teo very different learning environments. Although no type of proficiency scores on the subjects were available, by all other accounts they were matched for this test. If we then admit that both groups are fairly proficient, even if not exactly equivalent, then there is reason to suppose, based on the findings of the aforementioned studies, that proficiency would not have affected the laterality scores. Therefore, this researcher feels confident in making claims about the effects of the learning environment on lexical organization.

What needs to occur in the field of SLA, and this call has been repeated countless times in the literature over the past few years, is a controlled, longitudinal study of the same groups of learners from the moment of their first exposure to the language. From then on, periodical measurements of laterality and proficiency would then allow correlations to be made and conclusions to be drawn about not only laterality and proficiency, but also the learning environment.

We will never have too much data on language organization in the brain. Even if a study claims to answer one question, it raises others. This study proposed to examine how learning environment can effect the hidden processes of lexical storage and retrieval. While not statistically supporting the proposed hypotheses, all data showed supporting trends. It is hoped that this study will give further impetus to neurolinguistic study among normal populations, that our knowledge of the linguistic workings of the brain might increase, along with the effectiveness of language teaching methods.

(Appendix A)

DL EXPERIMENT PARTICIPANT SURVEY

This is a survey designed to isolate subjects for a dichotic listening test. Since we do not know yet who is eligible for the study, we ask for your name and class in order to identify you later. Once the subjects are selected, however, names will no longer be used and no further identification with you will be possible.

NAME _____.
CLASS _____.

Please answer all questions. When you are asked to give a written answer, do so as completely as possible.

I. Handedness

To answer each question, place the letter of the hand you consistently use to perform the task named: R=right hand; L=left hand; B=both hands interchangeably.

With which hand do you:

1. draw? _____
2. throw a ball to hit a target? _____
3. use an eraser on paper? _____
4. remove the top card for dealing? _____
5. write? _____
6. hold a toothbrush? _____
7. hammer? _____
8. use a bottle opener? _____
9. hold a potato while peeling? _____
10. use a screw driver? _____
11. use a tennis racket? _____
12. hold a bottle while removing the lid? _____
13. use scissors? _____
14. hold a match while striking? _____
15. hold a spoon to stir liquids? _____
16. pick up a salt shaker? _____
17. guide a thread through a needle? _____

(Appendix B)

Listening Instructions

You will wear a pair of headphones and listen to an audio tape. You will hear words in English and Spanish. After each group of words, there will be a ten second pause. Please say out loud everything you remember hearing. These responses will be recorded. Respond as quickly as you can. You will have a few practice words before beginning the test.

(Appendix C)

Word Pair Corpus

L / R

ENGLISH 2WP

word/leg
schedule/object

sex/piece
college/sentence

night/weak
ball/law

son/side
beard/cold

horse/floor
arm/turn

human/mother
woman/morning

hair/fear
movie/total

schedule/object
law/ball

side/son
turn/arm

morning/woman
sentence/college

morning/woman
word/leg

cold/beard
floor/horse

weak/night
fear/hair

total/movie
piece/sex

3WP

boss/house
mirror/shower
name/nose

alarm/police
paper/sunday
store/men

black/bank
witch/lunch
test/Christ

sign/skin
pill/hope
plane/dream

brother/spider
letter/bottle
suit/hate

fat/act
daddy/monday
month/birth

date/plan
hour/power
check/chair

Christ/test
skin/sign
hope/pill

dream/plane
spider/brother
bottle/letter

hate/suit
fat/act
monday/daddy

birth/month
plan/date
flour/hour

chain/check
witch/lunch
boss/house

shower/mirror
nose/name
police/alarm

sunday/paper
men/store
bank/black

4WP

ear/hell
picture/razor
answer/center
four/hole

mind/town
stick/paint
window/hundred
hotel/exam

group/square
job/food
person/cancer
rich/life

prize/stage
park/boat
kiss/bus
project/august

moment/rabbit
road/grade
smoke/paint
kid/God

age/orange
car/boy
shirt/street
day/two

child/thing
object/schedule
piece/sex
leg/word

cancer/person
life/rich
stage/prize
boat/park

bus/kiss
august/project
rabbit/moment
grade/road
point/smoke
God/kid
age/orange
boy/car

street/shirt
two/day
thing/child
schedule/object

sex/piece
word/leg
hell/ear
razor/picture

center/answer
hole/four
town/mind
paint/stick

hundred/window
exam/hotel
square/group
food/job

SPANISH 2WP

boda/miedo
navaja/trabajo

araña/caliente
bebida/domingo

respuesta/infierno
caballo/proyecto

sonido/camisa
horario/almuerzo

pierna/puente
agosto/momento

cena/saco
persona/palabra

año/odio
cheque/grado

domingo/bebida
infierno/respuesta

proyecto/caballo
camisa/sonido

almuerzo/horario
puente/pierna

momento/agosto
saco/cena

palabra/persona
odio/año

grado/cheque
miedo/boda
trabajo/navaja
caliente/araña

3WP

papel/nariz
colegio/objeto
cuento/cristo

total/papá
chico/fecha
treinta/carta

cancer/negro
barco/mente
vuelta/premio

cuatro/punto
poder/hotel
naranja/tablado

brazo/pieza
mes/bus
espejo/izquierda

cien/plan
tierra/carro
mujer/señal

cuadro/suelo
camión/edad
pelo/rico

mente/barco
premio/vuelta
punto/cuatro

hotel/poder
tablado/naranja
pieza/brazo

bus/mes
izquierda/espejo
plan/cien

carro/tierra
señal/mujer
suelo/cuadro

edad/camión
rico/pelo
nariz/papel

objeto/colegio
cristo/cuento
papá/total

fecha/chico
carta/treinta
negro/cancer

4WP

hijo/dia
foto/lunes
acto/humo
humano/mañana

rincón/avión

centro/noche
lado/tienda
sexo/ducha

gordo/Dios
anhelo/hermano
jefe/casa
banco/barba

palo/silla
reporte/pelota
grupo/frase
hueco/parque

ventana/terreno
hombre/sueño
privado/examen
diez/pie

nombre/pueblo
vida/niño
boda/miedo
navaja/trabajo

araña/caliente
bebida/domingo
respuesta/infierno
caballo/proyecto

pie/diez
pueblo/nombre
niño/vida
miedo/boda

trabajo/navaja
caliente/araña
domingo/bebida
infierno/respuesta

proyecto/caballo
dia/hijo
lunes/foto
humo/acto

mañana/humano
avión/rincón
noche/centro
tienda/lado

ducha/sexo
gordo/Dios
hermano/anhelo

casa/jefe

barba/banco
silla/palo
pelota/reporte
frase/grupo

parque/hueco
terreno/ventana
sueño/hombre
examen/privado

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